Flower Bulbs

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Introduction:

Flower Bulbs: This term refers to all taxa of ornamental flowering "Bulbs" having true bulbs, corms, tubers, rhizomes, tuberous roots, or enlarged hypocotyls as underground storage organs (De Hertogh and Le Nard, 1993b). All of them are geophytes (Raunkiaer, 1934), a term that not only includes flower bulbs but also most herbaceous perennials, some fruits, e.g., strawberries, and some vegetables, e.g. asparagus. Commercially, over 60 taxa and thousands of cultivars of flower bulbs are grown on approximately 32,000 hectares (De Hertogh and Le Nard, 1993a). However, only six taxa comprise over 90% of the total acreage of bulbs produced. In 2000 (Anonymous, 2000), the world production of flower bulbs was: *Tulipa,* 39%; *Narcissus*, 20%; *Lilium*, 19%; *Gladiolus*, 8.5%; *Hyacinthus*, 4%; and *Iris*, 3%. In this review, only the basic guidelines for postharvest storage of these six genera will be provided. Because of the number of cultivars and their varied usage, details cannot be provided since the precise requirements for all taxa are complex. For example, can the tulip cultivar be "Precooled" for very early forcing and based on the growing season should the cultivar be given 34 °C immediately after harvest or placed at 17 to 20 °C. For detailed postharvest information of this nature, users must consult the articles cited.

Horticultural Usage: Commercially, flower bulb usage can be divided into two groups. The first group is the "Planting Stock." These are the propagation materials and are generally grown by specialized bulb growers. Thus, they will only be covered briefly in this review. For additional information, consult De Hertogh and Le Nard (1993a) and specific articles cited. The second group is the "Commercial Bulbs," which are primarily used for: forcing either as fresh-cut flowers or as potted growing and flowering plants; indoor or outdoor container plants; outdoor fresh-cut flower production; and gardens and landscapes (De Hertogh and Le Nard, 1993c).

Horticultural Objectives: Optimum postharvest storage conditions in combination with ideal bulb growing conditions and procedures are required to: (1) control (prevent, retard or accelerate) the flowering process from floral initiation to anthesis (Hartsema, 1961; Le Nard and De Hertogh, 1993a; Theron and De Hertogh, 2001), (2) assist in controlling certain diseases and insects (Baker, 1993; Byther and Chastagner, 1993; Van Aartrijk, 1995 and 2000), and (3) preventing physiological disorders (De Hertogh and Le Nard, 1993e). For each species, it is important to know: (1) precisely when flower initiation occurs; this can be before harvest, e.g., Hardy *Narcissus*, during postharvest storage, e.g., tulips and hyacinths, or after planting, e.g., the Easter lily; (2) the length of time required for floral development from initiation to anthesis, which is can be a few weeks to several months; (3) the optimal temperatures required to control the entire flowering process; this can range from -2 to 34 °C, depending on the species, etc.; (4) the sensitivity of the bulb species and/or cultivar to ethylene, which ranges from none to very sensitive; (4) the ventilation requirements, which range from none to high; (5) the moisture requirements, which range from none to high; and (6) the specific diseases and/or insects that can be controlled during the postharvest storage period, which can range from none to several. These and other aspects have been reviewed De Hertogh and Le Nard (1993a) and Hartsema (1961).

Transportation: About 75% of the flower bulbs used in the U.S. are imported and the remainder are domestically produced. In addition, all production areas are distant from the sites of utilization and essentially 99% must be transported for a few days to several weeks . Thus, all trucks and shipping containers must be able to provide the proper temperature, ventilation, and moisture requirements for the bulbs (Table l.). The normal rate of air exchange for bulbs requiring ventilation during transport is 150

m^{-3} h^{-1} (De Hertogh and Le Nard, 1993c). In addition, for bulbs like hyacinths and Dutch Iris, the RH must be controlled to minimize the development of diseases such as *Penicillium*. Therefore, on arrival, all bulb shipments must be carefully inspected for serious diseases and insects, ventilated as needed, and then properly stored (Table l). Also, stage of development of the apical meristem must be determined. De Hertogh (1996) has summarized packing, transportation, and storage requirements for forcing bulbs.

Major Postharvest Storage Factors:

Temperature: Professor Blaauw and his co-workers (Hartsema, 1961) clearly demonstrated that temperature was the most important factor controlling the growth and development and flowering processes of flower bulbs. They demonstrated that precise control was required and that the specific temperature optima varied for each bulb species and the desired time of flowering. The optimal temperatures can range from -2 to 34 °C depending on the bulb species, use, growing season, and cultivar. Examples for the six major taxa are provided below. Subsequently, De Hertogh and Le Nard (1993d) have classified the hardiness of flower bulbs into seven groups (Table 2). This classification is very important for the storage of non-planted bulbs (Table 1) because they have limited protection against extremes in temperatures. If they are stored or transported, even for short periods, at temperatures lower or higher than the required temperatures, most bulbs will be physiologically injured (Van Aartrijk, 1995 and 2000).

Ventilation: When the taxa require ventilation (Table 1), it is essential that the flower bulbs receive proper air circulation and exchange during all periods of postharvest storage. Thus, the application of these requirements must begin immediately after the grower harvests the bulbs and continue during transportation and subsequent handling by the wholesaler, forcer and/or retailer. The exact ventilation requirement is generally very specific. It can be very low, eg., *Eremurus* and *Liatris* which must be prevented from drying out, or very high, eg., tulips in which ventilation assists in preventing flower abortion and abnormalities and the removal of ethylene. In general, ventilation rates must be adapted to the storage temperature, ie., when higher temperatures are used, higher rates of ventilation must be used.

Moisture: There are two basic considerations for the moisture level used for bulb storage (Table 1). The first is to provide the optimum moisture level, which will prevent desiccation of susceptible bulbs. Thus, materials such as moist peat or wood shavings are used in combination with the various packaging materials, e.g., polyethylene. The second is the control of the RH during storage or transportation, which can minimize root development and prevent the development of diseases such as *Penicillium* on hyacinths, *Narcissus*, tulips, and Dutch Iris. In addition, this approach is an important technique to minimize the use of fungicides either prior to and/or after shipping. Since the registration of fungicides varies with each country and is always subject to change, users must consult with their appropriate governmental agency to determine which pesticides are approved.

Ethylene: With the exception of Dutch Iris (see information below), non-planted flower bulbs must not be exposed to ethylene. Most bulbs are physiologically sensitive to ethylene levels of 0.1 ppm and higher. In general, when the flower has been formed and is immature, this plant growth regulator causes either floral abnormalities or complete flower abortion. For very sensitive bulbs, eg., tulips, it is advisable to have the storage rooms analyzed for ethylene. Commercial ethylene services are available to monitor the level of ethylene in all floriculture facilities.

Modified Atmospheres: Research on the modification of the O_2, N_2, and CO_2 levels of the storage atmosphere has been reported for gladioli, lilies, and tulips (De Hertogh and Le Nard, 1993d). In Europe, this system is referred to as “Ultra Low Oxygen” (ULO) and is used commercially in the Netherlands for lily and tulip bulb storage (Anonymous, 1996a,b). However, the specific procedures used and the results have not been published in refereed journals.

Diseases and Insects: All users of flower bulbs must be familiar with the diseases and insects that affect each species (Baker, 1993; Byther and Chastagner, 1993; Van Aartrijk, 1995 and 2000). There are many pests, but usually there are only a few major ones for each species. Knowledge of the major pests and the conditions controlling their development can assist in either eliminating and/or minimizing their

effects during postharvest storage.

Major Flower Bulb Taxa:

***Gladiolus* (Gladioli)**

General Aspects: Cohat (1993) has reviewed the physiology, pests and other aspects of *Gladiolus*. Many diseases can affect Gladioli in storage and pre-storage fungicidal dips are generally used. Current registrations must be consulted for approved fungicides. Corms for commercial uses should be transported at 2 to 5 ºC under highly ventilated conditions, ie., about 2 m^{-3} h^{-1} 100 L^{-1} of corms. With the exception of a hot water treatment (see below), unplanted corms are never stored below 0.5 °C or above 30 °C (Cohat, 1993; Van Aartrijk, 1995).

Planting Stock: After being harvested, cleaned, and then graded, corms and cormlets used as planting stock are initially given 2 to 3 weeks at 15 to 23 ºC followed by 2 ºC under highly ventilated conditions for a minimum of 8 to 10 weeks. The latter is required to break the rest period (dormancy) of the corms and cormlets. Prior to planting, they are given 4 to 8 weeks at 20 to 30 ºC to promote sprouting. To control *Fusarium*, cormlets are stored at 20 to 25 °C for 8 to 12 weeks, then soaked in running water for 1 to 2 days at 20 °C and then given a hot water treatment (HWT) of 55 to 56 °C for 30 min.

Commercial Bulbs for Outdoor Uses: Horticulturally, the major uses for Gladioli corms are outside either for use as commercial fresh cut flowers or in gardens and landscapes. The large flowering corms for these uses must be provided with the same storage temperatures and conditions as the planting stock. Corms used for very long storage and, thus, very late flowering must be stored at 2 ºC until planted.

***Hyacinthus* (Hyacinths)**

General Aspects: Nowak and Rudnicki (1993) have reviewed the physiology, pests, and other aspects of hyacinths. Commercially, the Netherlands produces almost all of the bulbs used worldwide. The major storage disease for commercial sized hyacinth bulbs is *Penicillium.* It can be controlled with optimum ventilation conditions and a RH of 85 to 90%. Hyacinth bulbs should be transported and subsequently stored at 17 ºC under highly ventilated conditions. With the exception of the heat treatment to control *Xanthomonas hyacinthii* (see below), unplanted bulbs are never stored < 0 °C or > 25.5 °C (Nowak and Rudnicki, 1993; Van Aartrijk, 2000).

Planting Stock: The postharvest handling and storage of small sized hyacinth bulbs require precise conditions to control the bacterium *Xanthomonas hyacinthii* (Yellow Disease). After harvest, the bulbs are stored at 30 °C under highly ventilated and dry conditions until September 1; they are then given 2 weeks at 38 °C, followed by 3 days at 44 °C, and subsequently 25.5 °C until planted. Bulbs used for scooping and scoring and other large sized planting stock bulbs are stored under dry and highly ventilated conditions at 25.5 °C from harvest until planted.

Commercial Bulbs for Forcing: Two types of commercial bulbs are available for greenhouse forcing as either potted plants or fresh cut flowers. The first is "Prepared Bulbs" (PR), which are used for very early forcing. After being harvested in early June, the bulbs are stored under dry and highly ventilated conditions for 2 weeks at 30 ºC, followed by 3 weeks at 25.5 ºC, and then 23 ºC until the uppermost floret reaches Stage A_2. Subsequently, they are stored at 17 ºC until planted. "Regular Bulbs" (RG), which are used for medium and late forcing, are given 25.5 ºC followed by 4 weeks at 17 ºC prior to planting. De Hertogh (1996) has provided detailed forcing programs for hyacinths in North America.

Commercial Bulbs for Gardens and Landscaping: After being harvested, bulbs for these uses are stored dry and under highly ventilated conditions at 25.5 °C. They are shipped and subsequently stored at 17 °C.

***Iris Hollandica*. (Dutch Iris)**

General Aspects: De Munk and Schipper (1993) have reviewed the physiology, pests, and other aspects of Dutch Iris. The two major storage diseases of Dutch Irises are *Fusarium* and *Penicillium*. To assist in controlling these diseases, it is essential to always handle the bulbs carefully to minimize mechanical

damage, which provides sites for disease development. Pre-storage and pre-plant fungicidal dips are generally used for Dutch Iris. Current registrations must be consulted for approved fungicides. After harvest and up to planting, Dutch Iris bulbs should be stored at 50 to 60% RH to minimize root growth and development of *Penicillium*. In general, unplanted bulbs are never stored < 0 °C or > 30 °C (De Munk and Schipper, 1993; Van Aartrijk, 1995).

Planting Stock: The primary objective during postharvest storage of the bulbs is to prevent flower formation in order to produce round commercial sized bulbs in the field. In addition, the conditions should prevent the development of diseases. The control of flower initiation is very critical in 7/8 cm, in circumference, planting stock bulbs. This size group is known as "The In-between Size", since larger bulbs flower readily and smaller ones do not. These bulbs should be provided with the following postharvest temperatures: 23 ºC from harvest to 1 September, followed by 2 weeks at 30 to 35 ºC and then depending on the cultivar and bulb size, 5 to 9 ºC. Bulbs smaller than 7/8 cm, in circumference, are stored at 18 to 20 °C.

Commercial Bulbs for Forcing: Generally, bulbs for very early forcing are stored at 30 ºC for a few days after being harvested. This is necessary for bulb drying, cleaning, and grading. They are subsequently exposed to 500 ppm ethylene for 24 h. This treatment stimulates flower initiation, especially with small sized bulbs of some cultivars and bulbs not receiving sufficient heat in the field prior to being harvested. Bulbs for late and retarded (up to one year) forcing are placed at 30 ºC to suppress their growth and development. Prior to planting, they are "Precooled" at 5 to 9 ºC for 6 to 11 weeks, depending on the cultivar. After being pre-cooled, bulbs should be planted as quickly as possible and, if transported, the period should be as short as possible. De Hertogh (1996) has provided forcing programs for Dutch Iris used as fresh cut flowers in North America.

Commercial Bulbs for Outdoor Uses: Dutch Irises are grown outdoors as commercial fresh cut flowers and in gardens and landscapes. After being harvested, these bulbs are initially stored at 30 ºC and then shipped and stored at 17 ºC until planted. When necessary, bulbs can be pre-cooled for 3 to 4 weeks at 5 to 9 °C.

***Lilium* (Lilies):**

General Aspects: In North America, generally there are two basic types of commercial lilies that are used. They are: the "Easter Lily" (*L. longiflorum*), which is predominantly used as a flowering potted plant; and a wide range of hybrid and species lilies, which are used either as fresh-cut flowers, flowering potted plants, or in gardens and landscapes. When properly packed in moist peat, unplanted lily bulbs can be stored at -1 to -2 °C, but are normally never stored above 17 °C (Beattie and White, 1993; Miller, 1993; Van Aartrijk, 2000).

Easter Lily: Miller (1993) has reviewed the physiology of forcing and bulb production, pests, and other aspects of the "Easter Lily." These bulbs are produced in the coastal areas of Northern California and Southern Oregon. Immediately after being harvested and graded, the "Planting Stock" is planted in the field. The "Commercial Sized Bulbs" are immediately packed in moist peat in wooden cases and then sent to either the forcer or commercial bulb jobber. To flower properly, the bulbs must receive 6 weeks at 2 to 7 ºC either by: "Case Pre-cooling" in moist peat or being "Controlled Temperature Forced" (CTF) in pots in a moist planting medium. De Hertogh (1996) has provided forcing schedules for the "Easter Lily" in North America.

Hybrid Lilies: Beattie and White (1993) have reviewed the physiology, pests, and other aspects of the hybrid and species lilies. This breeding of these lilies is expending rapidly and many new cultivars are continuously being released. After being harvested, the bulbs are graded and cleaned. To properly flower them, the bulbs must be packed in moist peat, wrapped in polyethylene, and packed in trays which are used for storage and shipping. Subsequently, they require at least 6 to 8 weeks at 2 ºC before being planted for early forcing. For late and year-round forcing the bulbs are "Frozen-in" at -1 to -2 ºC after being pre-cooled for 6 to 8 weeks. Modified atmospheres (ULO) systems, although not new (Stuart et al., 1970), are being used for long storage of some hybrids (Anonymous, 1996a). This system is being

used because there are fewer negative effects of the long-term period of being "Frozen-in" (Van Aartrijk, 2000). An alternative to this system is to produce the bulbs in the Southern Hemisphere for fall planting in the Northern Hemisphere (Anonymous, 2001). "Planting stock" is stored at 2 ºC in moist peat until planted. De Hertogh (1996) has provided forcing guidelines for Asiatic and Oriental lilies in North America.

Narcissus **(Hardy Daffodils and "Paperwhites")**

General Aspects: There are two basic groups of *Narcissus*, the hardy *Narcissus* (daffodils) and the non-hardy "Paperwhite *Narcissus*." Hanks (1993) has reviewed the physiology, pests, and other aspects of these groups. With the exception of the hot water treatment (see below), non-planted hardy *Narcissus* bulbs are never stored > 34 °C (see early forcing below), while "Paperwhites" are not stored > 30 °C (Hanks, 1993). Neither group of bulbs is stored < 0 °C (Van Aartrijk, 1995).

Hardy Narcissus: By far, the largest group of *Narcissus* is comprised of the hardy cultivars and there are hundreds of grown in many countries. The major storage diseases are *Fusarium* and *Penicillium* (Byther and Chastagner, 1993; Van Aartrijk, 1995). To control *Fusarium* in the "Planting stock", approved fungicides are added during a hot-water-treatment (HWT) of 1 to 2 h at 43.5 ºC. This treatment also controls nematodes and bulb flies. *Penicillium* can be controlled by use of proper ventilation conditions and a RH of 85 to 90%. Except for the HWT, "Planting Stock" bulbs are stored at 17 to 20 ºC. "Commercial Bulbs" for early forcing are given 1 week at 34 ºC followed by 17 ºC. All the other bulbs are provided 17 to 20 ºC. De Hertogh (1996) has provided forcing programs for hardy *Narcissus* cultivars in North America. Transportation of hardy daffodils either for forcing or garden and landscape use should be at 17 ºC under highly ventilated conditions.

"Paperwhite" Narcissus: Most cultivars of "Paperwhite" *Narcissus* bulbs are produced in Israel. They are not considered to be hardy bulbs, but can be planted outdoors in USDA Climatic Zones 9 to 11 (Cathey, 1991). "Planting Stock" and "Commercial Bulbs" are stored at 25 to 30 ºC after being harvested. "Commercial Bulbs" should be shipped at 25 to 30 ºC under highly ventilated conditions. After arrival, bulbs should be stored at 25 to 30 ºC until shoots begin to emerge. Subsequently, they should be placed at 2 ºC. Prior to planting, they require 2 weeks at 9 to 17 ºC. De Hertogh (1996) has provided forcing programs for Israeli-grown "Paperwhite" *Narcissus* in North America.

Tulipa **(Tulips)**

General Aspects: Le Nard and De Hertogh (1993b) have reviewed the physiology, pests, and other aspects of tulips. Without question, tulips are the largest taxa of flower bulbs grown and utilized throughout the world. Hundreds of cultivars are produced for forcing as fresh cut flowers, potted growing and plants, and for use in gardens and landscapes. The major storage diseases are *Fusarium* and *Penicillium*. Normally, *Fusarium* infections begin in the field and continue during postharvest storage. There are substantial differences in cultivar susceptibility, but it is important to reduce the number of infected bulbs in storage because of the ethylene they produce. This can lead to flower abortion and abnormalities. Thus, the bulbs must be routinely inspected and the rooms monitored for ethylene. Levels in the storage rooms must not exceed 0.1 ppm. In storage, *Penicillium* can be controlled with high rates of ventilation and RH of 85 to 90%. Regardless of the horticultural usage, tulip bulbs should be shipped at 17 ºC under a ventilation rate of 150 $m^3 h^{-1}$. With the exception of the 34 °C treatment for early forcing (see below), non-planted bulbs are never stored > 25 °C or < 0 °C (Le Nard and De Hertogh, 1993b; Van Aartrijk, 2000).

Planting Stock: After being harvested, bulbs are initially placed at 23 to 25 ºC for 3 to 4 weeks. Subsequently, depending on the cultivar, they are stored at progressively lower temperatures, ie., 23 to 20 ºC to 17 to 15 ºC until just before being planted. These temperatures are used to encourage enhanced production of large sized bulbs from the "Planting Stock".

Forcing Bulbs: For very early forcing, most cultivars are given 34 °C for 1 week immediately after lifting, subsequently; they are stored under dry and well-ventilated conditions at 17 to 20 °C.

Subsequently, it is very important to be able to identify the stages of flower initiation (Hartsema 1961), since most cultivars must reach "Stage G" prior to being pre-cooled at 5 to 9 ºC. For medium and late forcing, bulbs are placed at 17 to 23 ºC prior to planting at low temperatures. De Hertogh (1996) has provided forcing programs for cut and potted tulips in North America. Bulbs can also be stored under modified atmospheres (ULO) for Fall forcing (Anonymous, 1996b). However, bulbs are also grown in the Southern Hemisphere for planting in the Fall in the Northern Hemisphere (Anonymous, 2001). As with the hybrid lilies, this eliminates the need and effects of long storage periods.

Garden and Landscaping Bulbs: The key to utilization of tulip bulbs in North America is the USDA Climatic Zone (Cathey, 1990). In northern climatic zones, they naturally receive adequate cold exposure to satisfy their low temperature requirement. In warm climatic zones, they must be pre-cooled at 5 ºC for 8 to 10 weeks prior to planting. Normally, after being harvested, tulip bulbs for gardens and landscape usage are stored at 20 to 23 °C and then shipped and stored at 17 °C prior to being planted.

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Table 1. Packing and storage temperature requirements of ornamental flower bulbs, Adapted from De Hertogh and Le Nard (1993c).

Taxa	Storage Requirements	Packing Requirements	Storage Temp (ºC)
Achimenes	Prevent from drying	Peat	10 to 15
Acidanthera	Dry and ventilated	None	20
Allium			
G*iganteum*	Dry and ventilated	None	25 to 28
Other Alliums	Dry and ventilated	None	20 to 23
Alstroemeria	Prevent from drying	Peat	1 to 3
A. belladonna	Prevent from drying	Peat	13 to 23
Anemone			
blanda & *fulgens*	Dry and ventilated	None	9 to 17
c*oronaria* (Summer)	Dry and ventilated	None	15 to 25
c*oronaria* (Winter)	Dry and ventilated	None	10 to 13
Anigozanthos	Prevent from drying	Not reported	2 to 20
Begonia (Tuberous Hybrids)	Prevent from drying	Peat	2 to 5
Caladium	Dry and ventilated	None	23 to 25
Camassia	Prevent from drying	Wood shavings	17 to 20
Canna	Prevent from drying	Peat	5 to 10
Chionodoxa	Prevent from drying	Wood Shavings	20
Clivia	Prevent from drying	Peat	13
Colchicum	Prevent from drying	Wood shavings	17 to 23
Convallaria	Keep frozen-in	Peat	-2
Crocosmia	Prevent from drying	Plastic	2 to 5
Crocus	Dry and ventilated	None	17 to 20
Cyclamen	Prevent from drying	Peat	9
Dahlia	Prevent from drying	Peat	5 to 10
Endymion (Scilla campanulata**)**	Prevent from drying, store in paper bags.	Wood shavings	20
Eranthis	Prevent from drying	Peat	5
Eremurus	Prevent from drying	Peat	5 to 7
Erythronium	Prevent from drying	Peat	5 to 9
Eucharis	Prevent from drying	Peat	20
Eucomis	Dry and ventilated	None	13 to 20
Freesia	Dry and ventilated	None	
	Pre-Shipping		30
	Post-Shipping		9 to 13
Fritillaria imperialis	Prevent from drying	Wood shavings	23 to 25
and *Persica Meleagris*		Peat	2 to 5
Galanthus	Prevent from drying	Peat	17
Galtonia	Prevent from drying	Wood shavings	17 to 20
Gladiolus	Dry and ventilated	None	2 to 10
Gloriosa	Prevent from drying	Peat	10 to 18
Gloxinia	Prevent from drying	Peat	5 to 9
Haemanthus	Dry and ventilated	None	10 to 15
Hemerocallis	Prevent from drying	Peat	7 to 10
Hippeastrum	Prevent roots from drying	Peat or wood shavings	2 to 13
Hyacinthus	Dry and ventilated	None	17 to 20
Hymenocallis	Prevent from drying	Peat	7 to 10

Table 1 (continued)

Iris	Dry and ventilated	None	20 to 25
Dutch Hybrids	Dry and ventilated	None	17
English Hybrids	Prevent from drying	Peat	0 to 5
Germanica Hybids	Dry and ventilated	None	20 to 23
r*eticulata* & *danfordiae*			
Ixia	Dry and ventilated at 65-70% RH	None	20 to 25
Ixiolirion	Dry and ventilated	None	20
Lachenalia	Dry	Peat	9 to 25
A. Leucojum			
Aestivum	Dry and ventilated	None	20
Vernum	Dry and ventilated	None	2 to 5
Liatris	Prevent from drying	None	2 to -2
A. Lilium			
Longiflorum	Prevent from drying	Peat	2 to 7
Hybrids and species	Prevent from drying	Peat and polyethylene	2 to -2
Lycoris	Dry and ventilated	None	13 to 17
A. Montbretia	Prevent from drying	Plastic	2 to 5
B. Muscari	Dry and ventilated	None	20
C. Narcissus			
Hardy cultivars	Dry and ventilated	None	17
Paperwhites	Dry and ventilated	None	2 to 30
Nerine	Prevent from drying		
	Short term storage	Peat	17 to 21
	Long term storage	Peat	5 to 9
A. Ornithogalum			
Dubium	Dry and ventilated	None	9 to 30
Thyrsoides	Prevent from drying	Wood shavings	23 to 25
umbellatum & *nutans*	Prevent from drying	Wood shavings	20
Oxalis			
A*denophylla*	Prevent from drying	Wood shavings	17 to 20
Deppei	Dry and ventilated	None	2 to 5
Polianthes	Dry and ventilated	None	20
Puschkinia	Dry and ventilated	Wood shavings	20 to 23
Ranunculus			
Summer	Dry and ventilated	None	17 to 20
Winter	Dry and ventilated	None	10 to 13
Scadoxus	Dry and ventilated	None	10 to 15
Scilla siberica	Dry and ventilated	Wood shavings	20 to 23
Sparaxis	Dry and ventilated	None	25
Tigridia	In closed boxes	Peat	2 to 5
Triteleia (Brodiaea) laxa	Dry and ventilated	None	17 to 20
Tulipa	Dry and ventilated	None	17
***L.* Zantedeschia**	Dry and ventilated	Wood shavings	7 to 10
LI. Zephyranthes	Dry and ventilated	Polystyrene	17 to 20

Table 2. Hardiness classifications for ornamental flower bulbs.

Hardiness Classification	**Injured at temperatures below:**
Tender I	20 ºC
Tender II	10 ºC
Tender III	2 ºC
Semi-Hardy	-2 ºC
Hardy I	-5 ºC
Hardy II	-10 ºC
Hardy III	-15 ºC